Profitable Stauffer Chemical sticks to success formula
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Chemical & Engineering NEWS

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Membrane technology

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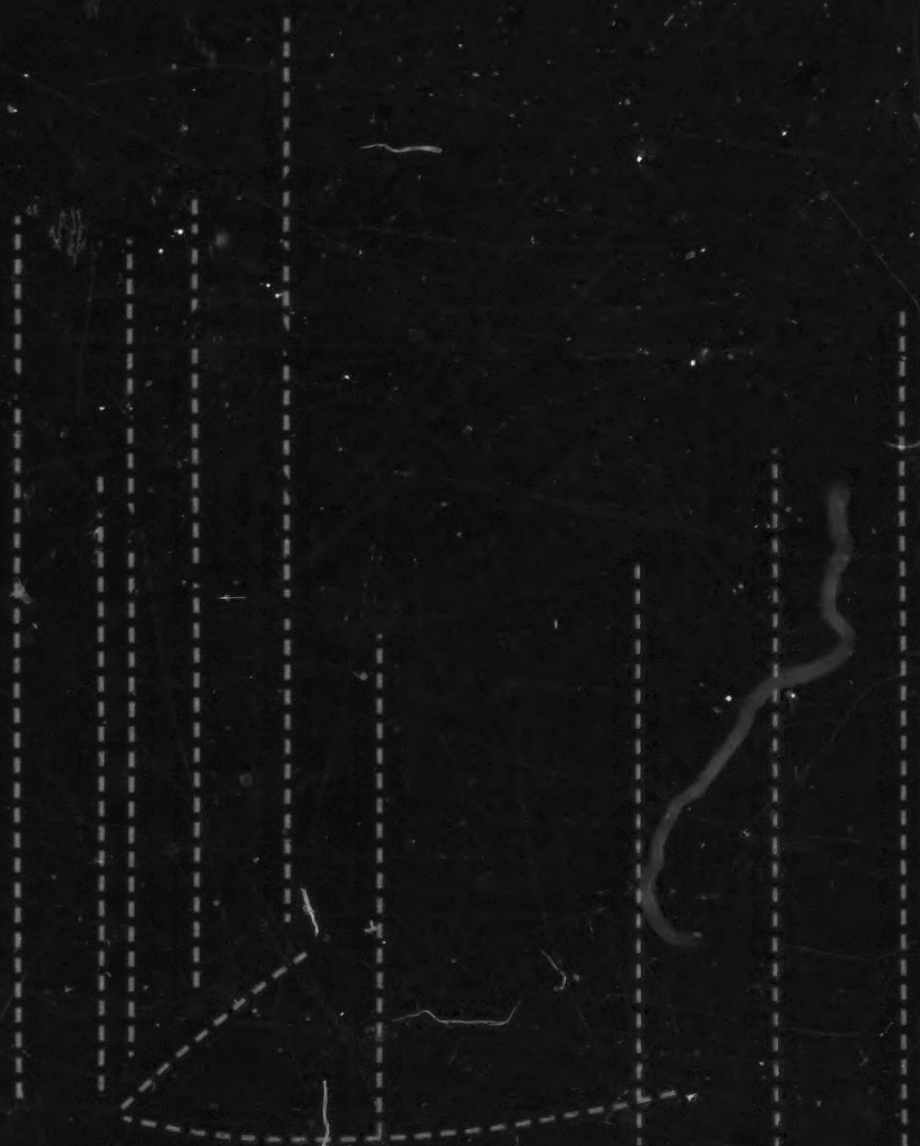

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Cover: Phase diagram, developed by C. A. Smolders at Twente University of Technology, the Netherlands, and his collaborators, helps show what happens when a dissolved polymer is treated with a mixture of solvent and nonsolvent during the membrane fabrication process

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- ***NRC study on nuclear power plant safety*** *stirs up controversy for not considering a worst-case scenario.* ***Page 5***
- ***EPA study on acid rain*** *links it inferentially to emissions from coal-fired plants in the Midwest.* ***Page 5***
- ***Ph.D. chemists receive higher wages*** *than most other scientists with a doctorate, according to NRC's latest survey.* ***Page 6***
- ***Montedison signs agreement with ENI*** *that is expected to lead to transfer of some petrochemical operations.* ***Page 6***

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- ***Chemical R&D budgets will rise again*** *in 1983, according to a recent survey by the National Science Foundation.* ***Page 17***
- ***Current world glut in aluminum*** *could turn to shortage by mid-1980s.* ***Page 18***

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Government

- ***Restructuring of agricultural research system*** *is proposed in a plan prepared by the Agricultural Research Service.* ***Page 23***

Science

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Technology

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down capacity was in ethylene, with some 3.9 billion lb shut down. The largest number of plants or units closed was in propylene, with 11 plants shutting down some capacity.

Despite those closedowns, however, overall capacities have risen. For example, since 1978, ethylene capacity has risen 16% to 38 billion lb per year; propylene has risen 17% to 20 billion lb; butadiene 5% to 5.1 billion lb; benzene 3% to 1.83 billion gal per year; and toluene 8% to 1.3 billion gal. Only chlorine capacity declined, falling 2% to 26.2 billion lb.

By Eldib's analysis, the 10 largest-volume producers account for more than half the total capacity for each of the major petrochemicals and for chlorine. For ethylene, for example, the top 10 have 53% of the total 38 billion lb-per-year capacity in the U.S. Butadiene is an even more concentrated industry, with the top nine producers having 65% of the 5.1 billion lb-per-year capacity in the U.S.

In the future, though, those top producers—as well as other producers—will be facing a dramatically different competitive picture. From the present average 65% capacity utilization rate for petrochemicals, by Eldib measures, use will begin rising, fueled by a modest but steady growth in demand of 3 to 4% per year over the next few years. Given present capacity, the demand line will cross supply in 1990 or 1991, with the present situation of excess capacity becoming unmet demand.

New capacity therefore will be needed—but it may very well not be built in the U.S. Petrochemical complexes being planned and built outside the U.S.—for example, in Mexico, Canada, and Saudi Arabia—may be able to produce cheaply enough to provide tough competition. □

Chemical R&D funding up again in 1983

All year long, questions have lingered whether the U.S. chemical industry finally would relent in the breathless pace of its research and development funding gains in recent years. After all, the severe recession the industry has been going through has hobbled many other spending programs.

No such thing, concludes the National Science Foundation after its first poll expected to become annual, of industrial companies to get early estimates of coming R&D budgets for work in the U.S. NSF's Industry Studies Group has started the new surveys to supplement its existing R&D studies, which generally run two years behind the current pace.

From data gathered last spring, the Industry Studies Group projects R&D funding gains of 17% in 1982 and 14% in 1983 for chemicals and allied products companies (including drug firms). As R&D budgets go, these percentages are large and will keep funding comfortably ahead of R&D inflation.

NSF's projections are not far from C&EN's own data on expected R&D budgets this year at the leading basic chemical producers. C&EN's latest tally projects total R&D spending will be up 18% in 1982 after a 20% increase in 1981 (C&EN, June 14, page 55). C&EN expects to publish its 1983 survey early next year.

The Industry Studies Group comments that the chemical industry is expected to exhibit the highest percentage increases in company R&D spending from 1981 through 1983 of any major R&D-performing industry. The average gains through all industries are projected at 10% in 1982 and 8% in 1983.

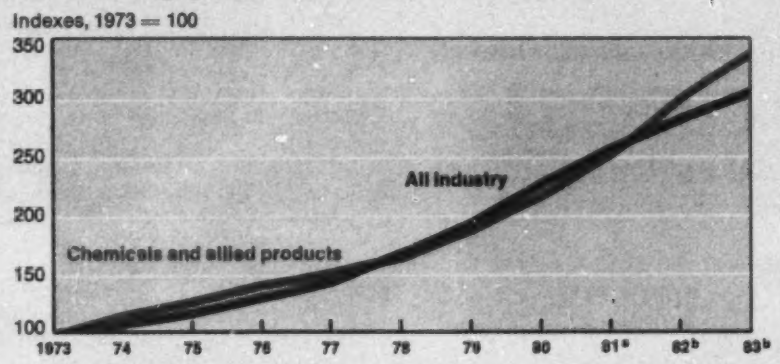
The studies group attributes the strong showing by chemical companies to several factors. Chemical firms have increased R&D dollars to explore recent breakthroughs in biology and biochemistry, especially in genetic engineering. Also, many firms are diversifying rapidly into new product areas such as agricultural chemicals and drugs, where entry requires substantial R&D investment.

Drug companies echo the optimism of chemical firms. NSF estimates R&D spending at drug firms up 20% in both 1982 and 1983. Reasons behind this growth are recent major medical breakthroughs, marketing opportunities in new and evolving technologies, and U.S. and foreign competition. Drug firms also regard the new federal tax credit for increased R&D expenditures and the movement of the Food & Drug Administration toward shorter drug approval times as positive influences on increased R&D budgets for U.S. operations. The response to the tax measure contrasts with a general lack of excitement over it at many companies in other industries. □

Chemical firms' R&D funding pushes up strongly in 1982 and 1983 compared to other industries . . .

$ Millions	1983 projected	1982 projected	1981 estimated	1980 actual	% change 1982–83	% change 1981–82
Chemicals and allied products	$ 6,530	$ 5,730	$ 4,900	$ 4,201	14%	17%
Instruments	3,325	2,920	2,540	2,139	14	15
Electrical equipment	7,685	7,050	6,300	5,414	9	12
Machinery	6,885	6,375	5,900	5,221	8	8
Motor vehicles	4,690	4,470	4,300	4,240	5	4
Aircraft and missiles	3,185	3,250	3,100	2,730	−2	5
Other	7,925	7,480	6,840	5,995	6	9
TOTAL	$40,225	$37,275	$33,880	$29,940	8%	10%

. . . and pulls ahead of all industry's long-term R&D funding growth



a Estimated. b Projected. Source: National Science Foundation from industry surveys

European petrochemicals outlook not all bad

Demand for styrene likely to grow about 2% annually; butadiene and other unsaturated C-4s also are forecast to do well

All wasn't gloom and doom at this year's European Chemical Market Research Association's meeting in Oslo. Although the near-term outlook for business in general and for petrochemicals in particular hardly can be classed as bright, the 160 attendees gained a modicum of comfort from projections that demand for some products remain firm.

"Styrene has a good future," declares Alan Bateman of Dow Chemical Europe. He concurs in the "fairly widely held view" that consumption in Western Europe will grow about 1.5 to 2% annually over the next five years or so. "While historic rates have been higher, there's still growth predicted," he points out.

European styrene consumption last year was about 5.72 billion lb, most of it used captively by producers. Total demand is expected to move up to between 6.54 billion and 6.84 billion lb by 1990 if the growth rate foreseen materializes.

Bateman doesn't foresee much additional styrene capacity being installed in Europe in the immediate future. This, coupled with a steady, if modest, demand growth augurs well for the operating economics of existing plants.

Like so many other petrochemical operations throughout Western Europe, styrene plants there are running at levels well below their potential, on average about 69% of their design capacity. This could rise to a more economically attractive 84% level by the end of the decade, assuming Bateman's contention that no new units appear on the local scene, and that the projected annual rate of growth materializes.

There now are 10 companies making styrene in Western Europe with a current combined annual capacity of some 7 billion lb. Dow is the biggest. Its units at Terneuzen, the Netherlands, have a total rated capacity of more than 1.5 billion lb annually. Other big names in the styrene producers' league are BASF at Ludwigshafen (1 billion lb); Rheinische Olefinwerke, jointly owned by BASF and Deutsche Shell, at Wesseling, also in West Germany (924 million lb); Montedipe, the petrochemicals arm of Montedison, at Mantova, Italy (770 million lb); and Shell Nederland Chemie at Moerdijk, the Netherlands (715 million lb).

Bateman doesn't expect the Middle East to pose a significant threat to established European producers. "Compared to ethylene capacity, projected [Middle East] styrene capacity is small," he points out—about 1.3 billion lb per year.

"The prime reason for this is that the raw material position [there] does not justify the investment costs," he says. "The only raw material advantage could be in the ethylene cost. However, ethylene contributes only one third by weight of the raw material, whereas benzene constitutes two thirds of the styrene molecule. It is unlikely," he maintains, "that benzene costs from Middle East reformers will show any advantage to benzene produced in Western Europe."

The pattern of European styrene use isn't likely to change significantly from the present profile, Bateman contends. About 50% now goes to make general-purpose polystyrene. A further 19% goes to expandable polystyrene, which "will grow at higher rates than the other end uses through the balance of the decade," he expects. Next in importance follow styrene-butadiene latex and rubbers, 12%; acrylonitrile-butadiene-styrene and styrene-acrylonitrile polymers, 9%; and unsaturated polyester resins, 5%. Miscellaneous outlets make up the 5% or so balance.

Bateman admits to being "fascinated by the replacement of polystyrene by polypropylene," wondering whether further substantial substitution will take place and so bite into the largest single styrene outlet. "Polystyrene will more than hold its own against polypropylene," he predicts. "One reason for my optimism is that expandable polystyrene is capable of greater stimulation than is polypropylene."

Probably more to the point is the projected decline in propylene availability stemming from closure of naphtha crackers to correct for the large ethylene overcapacity, coupled with the trend in Western Europe to shift from naphtha and gas oil as cracked feedstocks to liquefied petroleum gas and ethane with the resultant drop in coproduct propylene.

Butadiene and isobutene supply will remain tight, but *n*-butenes will be more plentiful

Millions of lb	Demand 1981	Demand 1990	Annual change	1990 surplus (or deficit)
Butadiene	**10,692**	**13,200**	**2.4%**	—
Western Europe	2,519	2,860	1.4	660
North America	3,608	4,180	1.6	(286)
Japan	1,276	1,518	1.9	(198)
Eastern Europe	2,420	3,300	3.5	(88)
Rest of world	869	1,342	4.9	(88)
Isobutene	**4,224**	**7,238**	**6.2**	**(264)**
Western Europe	1,342	2,200	5.6	(176)
North America	2,112	3,410	5.5	(1980)
Japan	396	572	4.2	418
Eastern Europe	308	836	11.7	1034
Rest of world	66	220	14.3	440
***n*-Butenes**	**2,574**	**3,080**	**2.0**	**660**
Western Europe	638	814	2.7	550
North America	1,507	1,298	−1.6	(242)
Japan	264	391	4.6	44
Eastern Europe	132	242	7.0	418
Rest of world	33	330	29.2	(110)

Source: BP Chemicals

Admittedly, this trend also will lead to a drop in cracker-derived benzene needed for making styrene. But, as Bateman notes, "Benzene is an internationally traded commodity, propylene is not."

He discounts any widespread use of oil refinery product streams as a propylene source. Such propylene requires upgrading to polymer quality material. The cost of such an upgrading unit with an annual capacity of 396 million lb has been pegged at $20 million. "That's not too much in the size of investments in the petrochemical industry," he acknowledges.

"But it's not the whole story. Propylene is a gas, and it needs special boats, rail cars, or pipelines to move it. An alternative would be to build polypropylene units where the upgraded refinery propylene is produced." Such units don't come cheap, however. It would cost about $70 million for a 165 million lb-a-year polypropylene unit in contrast to $30 million for the same size polystyrene plant, he notes.

The unsaturated C-4s—butadiene, isobutene, butene-1, and butene-2—have considerably better prospects for growth and profitability in Western Europe compared with ethylene, predicts BP Chemicals' Iain Steel. "This bullish forecast is based on modest growth of the synthetic rubbers, and continuing good prospects for isobutene-based products augmented by methyl *tert*-butyl ether (MTBE). *n*-Butene consumption will increase due to demand for butene-1 as a linear low-density polyethylene comonomer."

Global supply and demand of butadiene is expected to remain in balance throughout the decade, growing at an annual average rate of almost 2.4% from last year's 10.7 billion lb to 13.2 billion lb in 1980. Western Europe will continue to outpace local use, supplying the needs of Eastern Europe, Japan, North America, and other areas.

World isobutene demand likely will grow nearly 6.2% per year between 1981 and 1990, outpacing the 2.9%-per-year availability increase. Consequently, an overall supply deficit of 264 million lb will develop by 1990 from last year's surplus of nearly 1.2 billion lb.

Growth in world supply of the *n*-butenes will outpace demand. By 1990, therefore, availability could reach 660 million lb from last year's 264 million lb total. North America will remain in deficit supply throughout the period. However, a declining growth rate there, coupled with increasing local availability, will narrow the gap from last year's 759 million lb to 242 million lb.

The butadiene growth rate forecast of 2.4% per year through 1990 is low compared with the projections of others, Steel admits. But he believes his estimate to be realistic because of the slowing demand for butadiene-based synthetic rubbers. "Some two thirds of butadiene derivatives are consumed in cars and trucks as tires, hoses, etc., so demand closely reflects the fortunes of the transport industry," he notes.

The main isobutene derivatives, MTBE and butyl rubber, also are dependent on the transport industry. Last year, these two outlets consumed 57% of the chemical. The balance went toward making oligomers and polymers used as solvents, oil additives, adhesives, mastics, and other high-added-value materials.

There has been a mixed reaction from the oil companies to the use of MTBE as an octane improver in gasoline, he admits. Aromatics, when they are available, usually are preferred on a cost basis. So the forecast for MTBE use is speculative.

With MTBE, isobutene's overall annual growth rate likely will be 6.2% during the remainder of the decade, Steel believes. "Without this outlet, growth is expected to be 2.4% per year—2% per year for butyl rubber, 3% for oligomers and the various polymers of isobutene, and 4% for lesser outlets, which include some use for methyl methacrylate production, particularly in Japan, in the late 1980s.

"The 2%-per-year growth rate forecast for *n*-butenes demand throughout the decade conceals considerable activity," he notes. On the one hand, there is likely to be a decline in the use of *n*-butenes as a source of butadiene by dehydrogenation. Steel estimates that almost 15% of last year's global butadiene capacity of 16.6 billion lb was based on such dehydrogenation technology. In North America, fully 20% of the 5.4 billion lb butadiene capacity is accounted for by these units.

Steel expects that all butene dehydrogenation units in the U.S. will be closed permanently by the mid-1980s, because they cannot compete on energy terms with butadiene extraction from ethylene coproduct streams. Dehydrogenation plants are likely to be deemed viable only in South America and Eastern Europe, he believes.

The resulting decline in demand for the *n*-butenes will be countered by increased use of butene-1 in linear LDPE. "How fast butene-1 demand will grow is a matter of much debate," he says. "We in BP Chemicals believe that it will be the most cost-effective comonomer in the first phase of linear-LDPE development, but we are working on second generation alternatives."

On the supply side, Steel foresees a slight fall in the ratio of butadiene to ethylene in Western Europe's cracker product streams because of increasing use of lighter cracker feedstocks. Naphtha and gas oil, for instance, yield upward to 16 lb of butadiene per 100 lb of ethylene depending on the cracking conditions. Liquefied petroleum gas, on the other hand, yields less than 6 lb, whereas the amount of butadiene that results from cracking ethane is negligible.

The U.S. trend is opposite to that in Western Europe. The move is toward heavier cracking feedstocks, so the ratio of butadiene in the product streams will be higher than has been the case in the past. On the other hand, the likely closure of butene dehydrogenation plants will reduce the amount of butadiene available from that source. Elsewhere, butadiene production will increase as new petrochemical complexes are brought on stream.

In spite of these changes, Western Europe will remain the world's butadiene supplier, Steel contends. "Despite dependence on the transport industry with its low growth forecast, butadiene worldwide will tend toward balance or tightness," he says. "This means that current price levels will stabilize or move up, with corresponding benefit to producers' economics."

As for isobutene, its primary source in Western Europe and North America will continue to be "raffinate-I," the isobutene-rich fraction following removal of butadiene from a cracker's product stream. Here again, the isobutene content depends on the nature of the cracker feedstock.

Balance between local supply and demand will be tight, so Steel foresees a rising isobutene price profile. In contrast to the outlook for butadiene and isobutene, he envisages no shortage of *n*-butenes through the 1980s. The *n*-butenes are the main components of "raffinate-II," the stream remaining after removal of isobutene from raffinate-I. But any surplus *n*-butenes won't be wasted. Alkylate and polymer gasoline will provide major outlets. □